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- (54) **VEHICLE MAINTENANCE REMINDERS**
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B60R 16/023 (2006.01)
- (52) **U.S. Cl.**
CPC **G07C 5/006** (2013.01); **G05B 23/0283** (2013.01); **B60R 16/0234** (2013.01)
- (58) **Field of Classification Search**
CPC G07C 5/006; G05B 23/0283; G05B 23/0218; G05B 23/00; B60R 16/0234
See application file for complete search history.

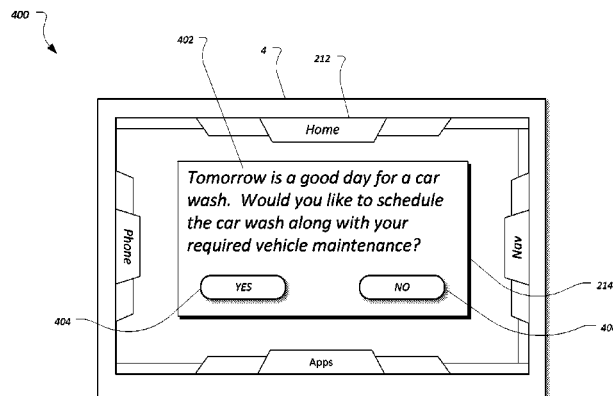
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(57) **ABSTRACT**

A system may determine, based on vehicle data received from vehicle sensors, a maintenance indication indicative of vehicle maintenance required according to a vehicle maintenance schedule, identify a maintenance time indication for which a maintenance procedure unrelated to the vehicle maintenance schedule should be performed, and generate a maintenance recommendation to provide in a vehicle human-machine interface offering to perform the vehicle maintenance and the unrelated maintenance procedure. The system may also identify, based on driver maintenance preferences, a weather-specific maintenance procedure unrelated to a vehicle maintenance schedule, identify a maintenance time indication according to properties of weather appropriate for the weather-specific maintenance procedure and weather forecast data queried from a weather service, and present a maintenance recommendation offering to perform required vehicle maintenance and the weather-specific maintenance procedure at a time indicated by the maintenance time indication.

20 Claims, 5 Drawing Sheets



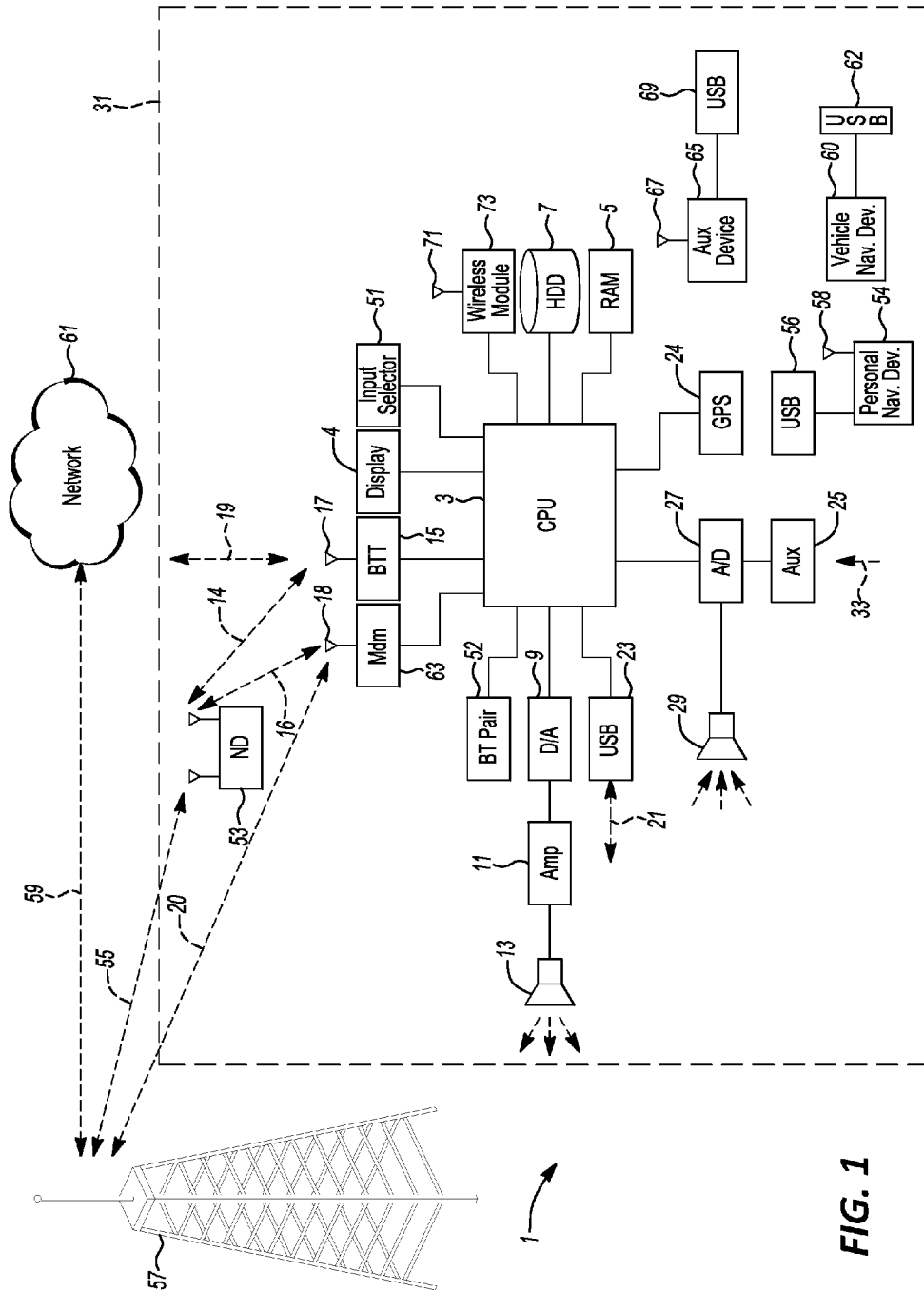


FIG. 1

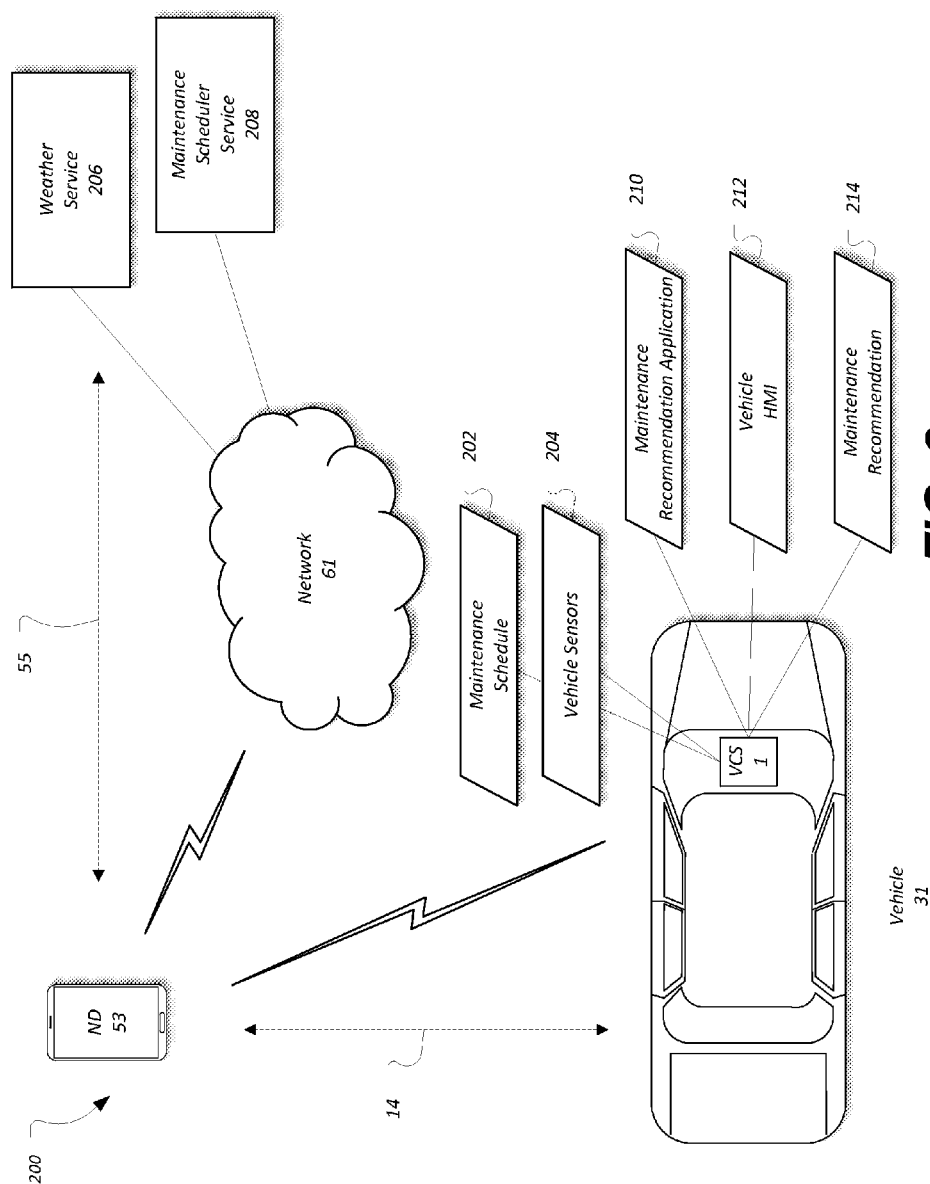


FIG. 2

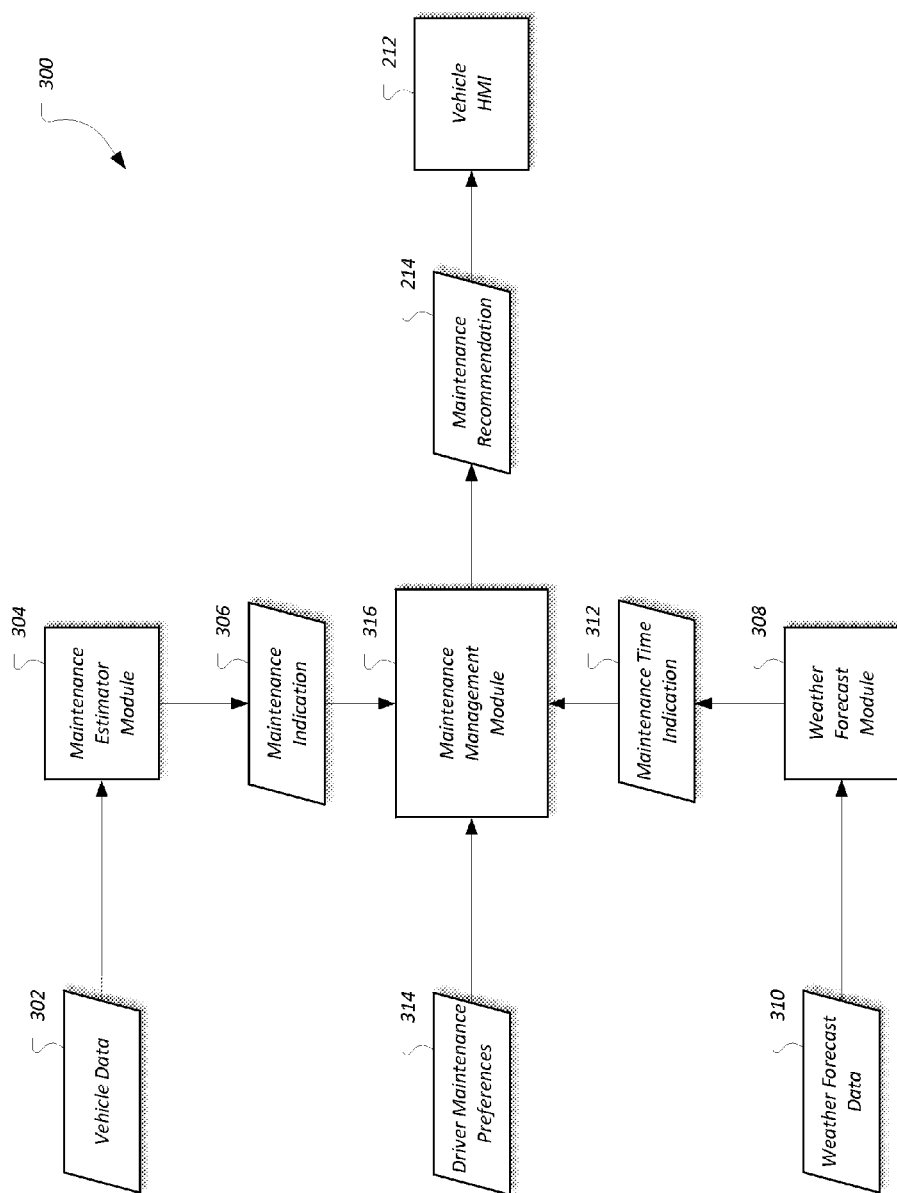


FIG. 3

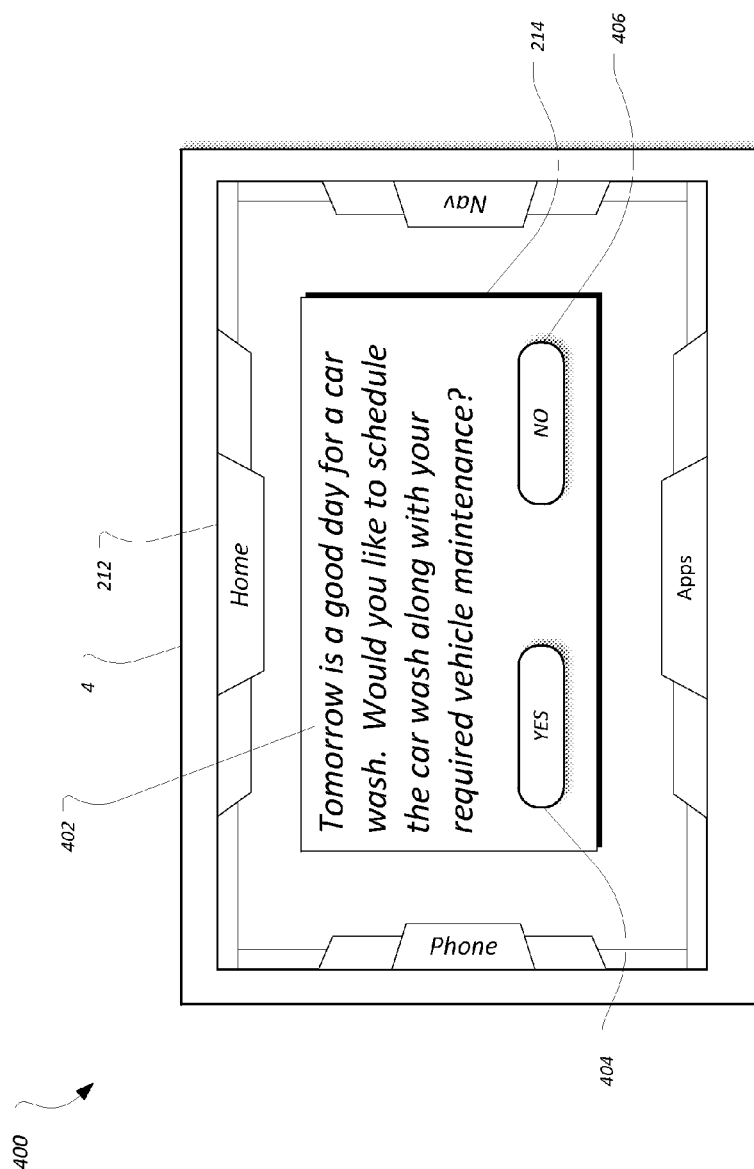
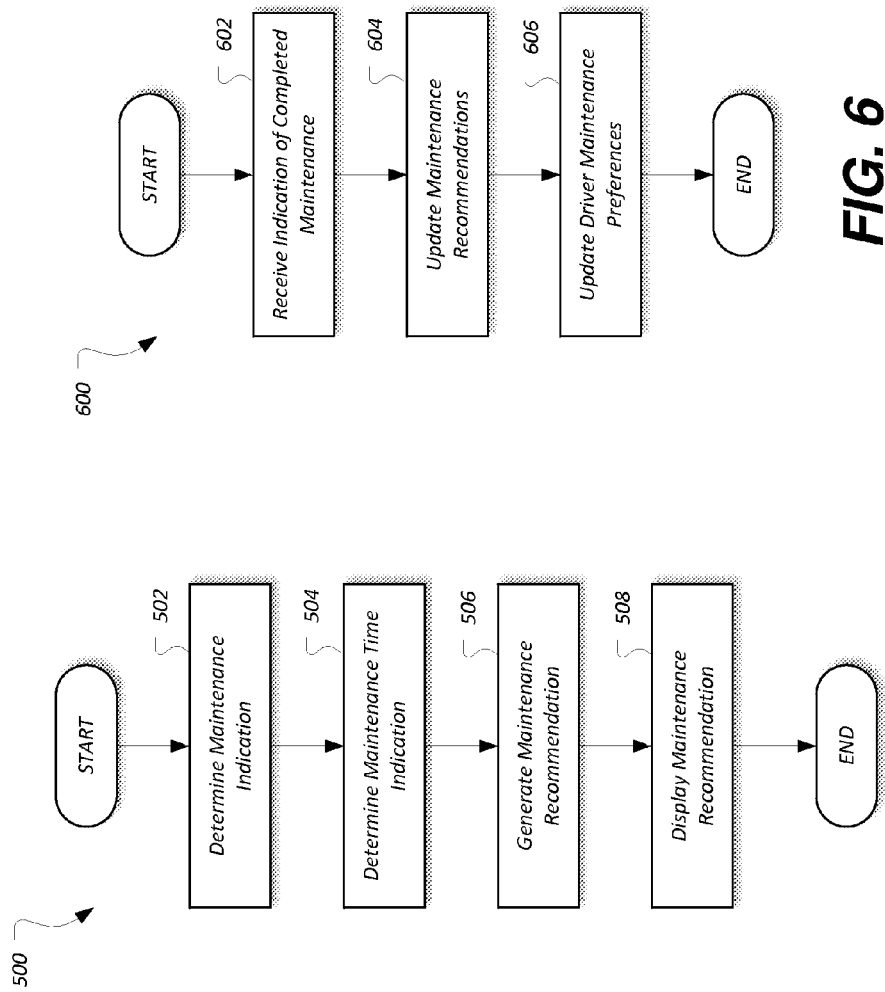


FIG. 4



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VEHICLE MAINTENANCE REMINDERS**TECHNICAL FIELD**

This disclosure generally relates to providing maintenance reminders for a vehicle according to a vehicle maintenance schedule.

BACKGROUND

Vehicles, such as automobiles, require routine maintenance. However, many vehicle owners delay or omit routine maintenance procedures recommended by the vehicle manufacturer. Deferred or omitted vehicle maintenance may cause premature wear or even failure of vehicle components. The vehicle owner may blame this wear on the manufacturer, rather than on his or her own failure to maintain.

SUMMARY

In a first exemplary embodiment, a system includes a processor configured to determine, based on vehicle data received from vehicle sensors and a vehicle maintenance schedule, a maintenance indication indicative of vehicle maintenance that is due, identify a maintenance time indication for performing a weather-specific maintenance procedure unrelated to the vehicle maintenance schedule, and generate a maintenance recommendation offering to perform the vehicle maintenance and the unrelated maintenance procedure at a time indicated by the maintenance time indication.

In a second exemplary embodiment, a system includes a processor configured to identify, based on driver maintenance preferences, a weather-specific maintenance procedure unrelated to a vehicle maintenance schedule, identify a maintenance time indication according to properties of weather appropriate for the weather-specific maintenance procedure and weather forecast data queried from a weather service, and present a maintenance recommendation to perform required vehicle maintenance and the weather-specific maintenance procedure at a time indicated by the maintenance time indication.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exemplary block topology of a vehicle infotainment system implementing a user-interactive vehicle based computing system;

FIG. 2 illustrates an exemplary vehicle having a maintenance recommendation application and vehicle sensors, and in communication with a weather service and calendar service via a network;

FIG. 3 illustrates an exemplary block diagram of a system using the maintenance recommendation application to provide maintenance recommendations to the driver;

FIG. 4 illustrates an exemplary user interface illustrating a maintenance recommendation displayed by the maintenance recommendation application in the vehicle human-machine interface;

FIG. 5 illustrates an exemplary process for providing maintenance recommendations; and

FIG. 6 illustrates an exemplary process for updating the vehicle computing system with respect to maintenance being performed to the vehicle.

DETAILED DESCRIPTION

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that

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the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. The figures are not necessarily to scale; some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present invention.

A vehicle may determine, based on a vehicle maintenance schedule and input from vehicle systems, that the vehicle maintenance is due to be performed. For example, a vehicle computing system (VCS) may be configured to receive information from vehicle sensors regarding fill level or other properties of a vehicle fluid (e.g., oil, coolant, etc.), as well as to determine based on the information whether or not the fluid requires changing. As another example, the VCS may be configured to identify remaining life of a fluid based on indirect information, such as vehicle miles driven, the average speed of the vehicle during those miles and the temperature of the vehicle or environment during those miles. If vehicle maintenance should be performed, the VCS may be configured to provide a reminder to the driver in a human-machine interface (HMI) of the vehicle (e.g., on a display, via a warning light, etc.). The VCS may be similarly configured to determine when other vehicle wear items require servicing, such as filters or brakes, and may provide warnings via the vehicle HMI when such service is indicated. Despite such warnings, vehicle owners may elect to defer vehicle service beyond when the maintenance schedule indicates it should be performed, potentially causing unnecessary vehicle wear or other issues.

A VCS may be further configured to identify, based on forecast weather conditions, a time appropriate for a maintenance procedure unrelated to the maintenance schedule. For example, the VCS may be configured to identify that an upcoming day may be appropriate for a car wash. To encourage the vehicle owner to perform the required vehicle maintenance, the VCS may be configured to provide a maintenance recommendation via the HMI for the required maintenance procedure due for the vehicle (e.g., for an oil change) based on appropriate weather/conditions for a maintenance procedure unrelated to the maintenance schedule (e.g., for the car wash). By providing the maintenance recommendation for the maintenance procedure unrelated to the maintenance schedule along with the maintenance recommendation for the vehicle service, the VCS may be able to improve compliance with the vehicle maintenance schedule, while also offering the vehicle owner suggested times to perform weather-related or other non-essential vehicle maintenance.

FIG. 1 illustrates an example block topology for a vehicle based computing system 1 (VCS) for a vehicle 31. An example of such a vehicle-based computing system 1 is the SYNC system manufactured by THE FORD MOTOR COMPANY. A vehicle enabled with a vehicle-based computing system may contain a visual front end interface 4 located in the vehicle. The user may also be able to interact with the interface if it is provided, for example, with a touch sensitive screen. In another illustrative embodiment, the interaction occurs through, button presses, spoken dialog system with automatic speech recognition and speech synthesis.

In the illustrative embodiment 1 shown in FIG. 1, a processor 3 controls at least some portion of the operation of the vehicle-based computing system. Provided within the vehicle, the processor allows onboard processing of com-

mands and routines. Further, the processor is connected to both non-persistent **5** and persistent storage **7**. In this illustrative embodiment, the non-persistent storage is random access memory (RAM) and the persistent storage is a hard disk drive (HDD) or flash memory. In general, persistent (non-transitory) memory can include all forms of memory that maintain data when a computer or other device is powered down. These include, but are not limited to, HDDs, CDs, DVDs, magnetic tapes, solid state drives, portable USB drives and any other suitable form of persistent memory.

The processor is also provided with a number of different inputs allowing the user to interface with the processor. In this illustrative embodiment, a microphone **29**, an auxiliary input **25** (for input **33**), a USB input **23**, a GPS input **24**, screen **4**, which may be a touchscreen display, and a BLUETOOTH input **15** are all provided. An input selector **51** is also provided, to allow a user to swap between various inputs. Input to both the microphone and the auxiliary connector is converted from analog to digital by a converter **27** before being passed to the processor. Although not shown, numerous of the vehicle components and auxiliary components in communication with the VCS may use a vehicle network (such as, but not limited to, a CAN bus) to pass data to and from the VCS (or components thereof).

Outputs to the system can include, but are not limited to, a visual display **4** and a speaker **13** or stereo system output. The speaker is connected to an amplifier **11** and receives its signal from the processor **3** through a digital-to-analog converter **9**. Output can also be made to a remote BLUETOOTH device such as PND **54** or a USB device such as vehicle navigation device **60** along the bi-directional data streams shown at **19** and **21** respectively.

In one illustrative embodiment, the system **1** uses the BLUETOOTH transceiver **15** to communicate **17** with a user's nomadic device **53** (e.g., cell phone, smart phone, PDA, or any other device having wireless remote network connectivity). The nomadic device can then be used to communicate **59** with a network **61** outside the vehicle **31** through, for example, communication **55** with a cellular tower **57**. In some embodiments, tower **57** may be a WiFi access point.

Exemplary communication between the nomadic device and the BLUETOOTH transceiver is represented by signal **14**.

Pairing a nomadic device **53** and the BLUETOOTH transceiver **15** can be instructed through a button **52** or similar input. Accordingly, the CPU is instructed that the onboard BLUETOOTH transceiver will be paired with a BLUETOOTH transceiver in a nomadic device.

Data may be communicated between CPU **3** and network **61** utilizing, for example, a data-plan, data over voice, or DTMF tones associated with nomadic device **53**. Alternatively, it may be desirable to include an onboard modem **63** having antenna **18** in order to communicate **16** data between CPU **3** and network **61** over the voice band. The nomadic device **53** can then be used to communicate **59** with a network **61** outside the vehicle **31** through, for example, communication **55** with a cellular tower **57**. In some embodiments, the modem **63** may establish communication **20** with the tower **57** for communicating with network **61**. As a non-limiting example, modem **63** may be a USB cellular modem and communication **20** may be cellular communication.

In one illustrative embodiment, the processor is provided with an operating system including an API to communicate with modem application software. The modem application

software may access an embedded module or firmware on the BLUETOOTH transceiver to complete wireless communication with a remote BLUETOOTH transceiver (such as that found in a nomadic device). Bluetooth is a subset of the IEEE 802 PAN (personal area network) protocols. IEEE 802 LAN (local area network) protocols include WiFi and have considerable cross-functionality with IEEE 802 PAN. Both are suitable for wireless communication within a vehicle. Another communication means that can be used in this realm is free-space optical communication (such as IrDA) and non-standardized consumer IR protocols.

In another embodiment, nomadic device **53** includes a modem for voice band or broadband data communication. In the data-over-voice embodiment, a technique known as frequency division multiplexing may be implemented when the owner of the nomadic device can talk over the device while data is being transferred. At other times, when the owner is not using the device, the data transfer can use the whole bandwidth (300 Hz to 3.4 kHz in one example). While frequency division multiplexing may be common for analog cellular communication between the vehicle and the internet, and is still used, it has been largely replaced by hybrids of Code Domain Multiple Access (CDMA), Time Domain Multiple Access (TDMA), Space-Domain Multiple Access (SDMA) for digital cellular communication. These are all ITU IMT-2000 (3G) compliant standards and offer data rates up to 2 mbs for stationary or walking users and 385 kbs for users in a moving vehicle. 3G standards are now being replaced by IMT-Advanced (4G) which offers 100 mbs for users in a vehicle and 1 gbs for stationary users. If the user has a data-plan associated with the nomadic device, it is possible that the data-plan allows for broad-band transmission and the system could use a much wider bandwidth (speeding up data transfer). In still another embodiment, nomadic device **53** is replaced with a cellular communication device (not shown) that is installed to vehicle **31**. In yet another embodiment, the ND **53** may be a wireless local area network (LAN) device capable of communication over, for example (and without limitation), an 802.11g network (i.e., WiFi) or a WiMax network.

In one embodiment, incoming data can be passed through the nomadic device via a data-over-voice or data-plan, through the onboard BLUETOOTH transceiver and into the vehicle's internal processor **3**. In the case of certain temporary data, for example, the data can be stored on the HDD or other storage media **7** until such time as the data is no longer needed.

Additional sources that may interface with the vehicle include a personal navigation device **54**, having, for example, a USB connection **56** and/or an antenna **58**, a vehicle navigation device **60** having a USB **62** or other connection, an onboard GPS device **24**, or remote navigation system (not shown) having connectivity to network **61**. USB is one of a class of serial networking protocols. IEEE 1394 (FireWire™ (Apple), i.LINK™ (Sony), and Lynx™ (Texas Instruments)), EIA (Electronics Industry Association) serial protocols, IEEE 1284 (Centronics Port), S/PDIF (Sony/Philips Digital Interconnect Format) and USB-IF (USB Implementers Forum) form the backbone of the device-device serial standards. Most of the protocols can be implemented for either electrical or optical communication.

Further, the CPU could be in communication with a variety of other auxiliary devices **65**. These devices can be connected through a wireless **67** or wired **69** connection. Auxiliary device **65** may include, but are not limited to, personal media players, wireless health devices, portable computers, and the like.

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Also, or alternatively, the CPU could be connected to a vehicle based wireless router **73**, using for example a WiFi (IEEE 803.11) **71** transceiver. This could allow the CPU to connect to remote networks in range of the local router **73**.

In addition to having exemplary processes executed by a vehicle computing system located in a vehicle, in certain embodiments, the exemplary processes may be executed by a computing system in communication with a vehicle computing system. Such a system may include, but is not limited to, a wireless device (e.g., and without limitation, a mobile phone) or a remote computing system (e.g., and without limitation, a server) connected through the wireless device. Collectively, such systems may be referred to as vehicle associated computing systems (VACS). In certain embodiments particular components of the VACS may perform particular portions of a process depending on the particular implementation of the system. By way of example and not limitation, if a process has a step of sending or receiving information with a paired wireless device, then it is likely that the wireless device is not performing the process, since the wireless device would not "send and receive" information with itself. One of ordinary skill in the art will understand when it is inappropriate to apply a particular VACS to a given solution. In all solutions, it is contemplated that at least the vehicle computing system (VCS) located within the vehicle itself is capable of performing the exemplary processes.

FIG. 2 illustrates an exemplary vehicle **31** having a maintenance recommendation application **210** and vehicle sensors **204**, and configured to communicate with a weather service **206** and maintenance scheduler service **208** via a network **61**. In an example, the VCS **1** of the vehicle **31** may be connected to a paired nomadic device **53** (e.g. via BLUETOOTH), such that the communications features of the nomadic device **53** may be used to allow the VCS **1** to communicate via the network **61** with the weather service **206** and maintenance scheduler service **208**. In another example, the VCS **1** may be configured to use an onboard modem **63** to communicate via the network **61**. As explained in detail below, the VCS **1** may be configured to execute the maintenance recommendation application **210** to cause the VCS **1** to utilize the vehicle sensors **204** and weather service **206** to provide maintenance recommendations **214** via a vehicle HMI **212**, as well as to set up appointments with the maintenance schedule service **208** via the network **61**.

The maintenance schedule **202** may include information related to maintenance operations that should be performed for the vehicle **31**. In some cases, one or more of the maintenance operations may be specified by the maintenance schedule **202** according to a predetermined interval of time or vehicle miles (e.g., whichever comes first). In other cases, one or more of the maintenance operations may be specified by the maintenance schedule **202** according to a predetermined amount of time or vehicle miles measured from vehicle **31** manufacture. The maintenance operations may include, as some non-limiting examples, oil changes, replacement of brake fluid, brake inspection, suspension inspection, lubrication of vehicle parts, tire rotation, air filter replacement, parking brake adjustment, belt replacement, spark plug replacement, coolant replacement, and idle speed adjustment.

The vehicle sensors **204** may include devices of the vehicle **31** configured to measure quantities relevant to operation of the vehicle **31**, as well as to provide a data signal to the vehicle **31** to inform the vehicle **31** regarding the measured quantities. The vehicle sensors **204** may include, as some non-limiting examples, a vehicle speed

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sensor, a throttle position sensor, a brake light switch sensor, an impact sensor, a coolant temperature sensor, an oil pressure sensor, an engine oxygen sensor, a power steering pressure switch, a steering angle sensor, a lateral acceleration sensor, a longitudinal acceleration sensor, a wheel speed sensor, a tire pressure sensor, an odometer sensor, and an oil temperature sensor.

The weather service **206** may be configured to provide information regarding current and forecast weather conditions. The information regarding weather conditions may include, for example, temperature (e.g., current, forecast low, forecast high, etc.), type of precipitation (e.g., rain, snow, sleet, hail, etc.), likelihood of precipitation (e.g., as a percentage), allergen status (e.g., pollen level, smog level, etc.) among other possibilities. In some cases, forecast weather conditions may be specified over a daily timescale, while in other cases, forecast weather conditions may be specified over a shorter timescale, such as hourly. The weather service **206** may be configured to receive requests for current and/or forecast weather conditions for a specified geographic location and date/time, and respond to the requests with the requested information.

The maintenance scheduler service **208** may be configured to manage appointments for vehicles **31** to have maintenance performed. For example, the maintenance scheduler service **208** may be configured to manage appointments for one or more dealers or other vehicle service centers, to allow customers to book times to have scheduled maintenance performed to their vehicles **31**. The maintenance scheduler service **208** may be further configured to keep track of what maintenance was performed, to allow the vehicle service centers to be aware of what maintenance was previously performed to the vehicle **31** and when.

The maintenance recommendation application **210** may be one example of an application program stored on a memory of the nomadic device **53** or VCS **1** (e.g., as software, firmware, etc.). When executed by one or more processors of the nomadic device **53** or VCS **1**, the maintenance recommendation application **210** may be configured to cause the nomadic device **53** or VCS **1** to perform various operations related to the determining and providing of maintenance recommendations **214** to the driver via the vehicle HMI **212**.

The vehicle HMI **212** may include various input hardware and output hardware serving to create a user interface for the driver and/or other vehicle occupants. Exemplary vehicle HMI **212** input hardware may include microphones for capturing audio input, and one or more user controls such as touch-screens, knobs or buttons (e.g., located on the vehicle dash, on the vehicle steering wheel, etc.). The vehicle HMI **212** may also include output hardware, such as one or more displays to provide visual output (e.g., a head unit touch-screen display, a display of the gauge cluster, etc.) and one or more speakers to provide audio output (e.g., via the vehicle **31** audio system).

The maintenance recommendation **214** may include information suggesting that the vehicle owner take the vehicle **31** in for servicing. For example, the maintenance recommendation **214** may specify a date or time at which the vehicle **31** is suggested to be taken in for servicing. The maintenance recommendation **214** may further include additional information regarding the servicing, such as the proposed maintenance to be performed, a cost for the maintenance procedures, and an indication of how immediate the need is for the recommended maintenance to be performed, as some possibilities. The maintenance recommendation **214** may fur-

ther include information indicative of whether or not the maintenance requested by the maintenance recommendation **214** has been performed.

The maintenance recommendation application **210** may be configured to determine, based on the maintenance schedule **202** and input from the vehicle sensors **204**, that vehicle maintenance is due to be performed. The maintenance recommendation application **210** may be further configured to identify, based on forecast weather conditions requested from the weather service **206**, a time appropriate for a maintenance procedure unrelated to the maintenance schedule **202**. For example, the maintenance recommendation application **210** may be configured to identify that an upcoming day may be appropriate for a car wash. To encourage the vehicle owner to perform the vehicle service required by the maintenance schedule **202**, the maintenance recommendation application **210** may be configured to provide the maintenance recommendation **214** via the vehicle HMI **212** for the maintenance procedure due for the vehicle **31** (e.g., oil change) based on appropriate weather/conditions for the maintenance procedure unrelated to vehicle wear items also included in the maintenance recommendation **214** and tied to the vehicle **31** (e.g., for a car wash).

By providing in the maintenance recommendation **214** an offer for a maintenance procedure unrelated to vehicle **31** wear along with the maintenance recommendation **214** for the vehicle servicing specified by the maintenance schedule **202**, the maintenance recommendation **214** may be able to improve operator compliance with the maintenance schedule **202**, while at the same time offering the vehicle owner good times to perform weather-related vehicle maintenance. Further details of the operation of the maintenance recommendation application **210** are discussed in detail below with respect to FIGS. 3-5.

FIG. 3 illustrates an exemplary block diagram **300** of a system using the maintenance recommendation application **210** to provide maintenance recommendations **214** to the driver. In an example, the modules of the maintenance recommendation application **210** may be implemented by one or more processors or microprocessors of the vehicle **31** (such as the CPU **3** of the VCS **1**) configured to execute the instructions of the maintenance recommendation application **210** stored on one or more memory devices of the vehicle **31** (such as the storage **5** and **7**). In other examples, the modules may be implemented by other combinations of hardware or hardware executing software and/or firmware configured to perform the operations discussed herein. As illustrated, the maintenance recommendation application **210** includes a maintenance estimator module **304** configured to receive vehicle data **302** and determine a maintenance indication **306**. The maintenance recommendation application **210** further includes a weather forecast module **308** configured to receive weather forecast data **310** from the weather service **206** and determine a maintenance time indication **312**. The maintenance recommendation application **210** also includes a maintenance delivery module **324** configured to receive the maintenance indication **306**, the maintenance time indication **312**, as well as driver maintenance preferences **314**, and determine a maintenance recommendation **214** to be displayed via the vehicle HMI **212**. It should be noted that the modularization of the maintenance recommendation application **210** illustrated in the diagram **300** is exemplary, and other arrangements or combinations of elements including more, fewer, or differently separated modules may be used.

The vehicle data **302** may include information retrieved from the vehicle sensors **204**. As some examples, the vehicle

data **302** may include information indicative of vehicle speed, yaw, pitch, roll, lateral acceleration, ambient temperature, accelerator pedal position, steering wheel angle, vehicle position, vehicle fluid temperatures, vehicle speed, and vehicle miles traveled. The maintenance recommendation application **210** may be configured to receive the vehicle data **302** from over a vehicle network. In an example, the vehicle network may be a controller-area network (CAN) network over which the vehicle sensors **204** may be configured to communicate.

The maintenance estimator module **304** may be configured to utilize the vehicle data **302** to identify whether any vehicle maintenance is required. For example, the maintenance estimator module **304** may be configured to identify whether the elements of the vehicle data **302** are indicative of maintenance that may be required according to the maintenance schedule **202** of the vehicle **31**. As a more specific example, the maintenance estimator module **304** may identify, based on the maintenance schedule **202** of the vehicle **31** and the vehicle miles traveled vehicle data **302** retrieved from a vehicle odometer vehicle sensor **204**, that an element of maintenance from the maintenance schedule **202** is due. As another example, the maintenance estimator module **304** may identify, based on the maintenance schedule **202** of the vehicle **31** and an amount of time since the last fluid change that a fluid change is due. As yet a further example, the maintenance estimator module **304** may identify, based on the maintenance schedule **202** of the vehicle **31** and temperature and average vehicle speed data that a fluid change is due.

When the maintenance estimator module **304** identifies that maintenance that may be required according to the maintenance schedule **202**, the maintenance estimator module **304** may be configured to generate a maintenance indication **306**. The maintenance indication **306** may indicate the item of maintenance that should be performed (e.g., oil change, new air filter, etc.). The maintenance indication **306** may also indicate a severity level for the item of maintenance that should be performed (e.g., a low priority where the maintenance does not require immediate action, a medium priority where the maintenance should be performed within a certain number of miles or days to preserve vehicle **31** operation or to avoid vehicle **31** damage, or a high priority where the vehicle **31** must not be driven until the maintenance is performed).

The weather forecast module **308** may be configured to query the weather service **206** for past, current or forecast weather conditions related to the timing for which the maintenance indication **306** indicates that maintenance should be performed. This retrieved information may be referred to as weather forecast data **310**, and may include temperature, precipitation, allergen and other information retrieved from the weather service **206**. Based on the weather forecast data **310**, the weather forecast module **308** may be configured to generate a maintenance time indication **312** indicative of one or more times deemed by the weather forecast module **308** as being suitable. For instance, the maintenance time indication **312** may indicate a time or times where the weather is not expected to include precipitation.

The driver maintenance preferences **314** may include information indicative of how a driver, owner or other person responsive for maintenance to the vehicle **31** prefers to have the maintenance performed. For example, the driver maintenance preferences **314** may include indications of locations previously used to service the vehicle **31**, times of day and days of the week during which the vehicle **31** was

previously put into service, and preferred maintenance procedures unrelated to vehicle wear items (e.g., car washes, vehicle detailing). As another example, the driver maintenance preferences 314 may include information requesting that the user not receive reminders to perform the preferred maintenance procedures unrelated to vehicle wear items before or after certain weather. For instance, the driver maintenance preferences 314 may indicate that the user does not wish to be reminded to wash the vehicle 31 for a specified amount of days before a forecast storm or after a recorded storm.

The maintenance management module 316 may be configured to receive maintenance indications 306 from the maintenance estimator module 304, request maintenance time indications 312 from the weather forecast module 308, and determine, based on the driver maintenance preferences 314 and maintenance time indications 312, a maintenance recommendation 214 to be provided to the driver via the vehicle HMI 212. For example, the maintenance management module 316 may be configured to determine, based on the maintenance time indications 312, a time suitable for a maintenance procedure unrelated to the maintenance schedule 202 that is preferred by the driver based on the driver maintenance preferences 314. Responsive to the determination, the maintenance management module 316 may be further configured to generate a maintenance recommendation 214 suggesting that both the maintenance procedure unrelated to the maintenance schedule 202 and the maintenance indicated by the maintenance indications 306 be performed at the time suitable for maintenance procedure unrelated to maintenance schedule 202. As a specific example, the maintenance recommendation application 210 may determine that as it may rain today but not for the next three days, and that the driver prefers car washes, a maintenance recommendation 214 should be generated suggesting that the driver schedule to have vehicle maintenance performed tomorrow as well as a car wash at the same time.

FIG. 4 illustrates an exemplary user interface 400 illustrating a maintenance recommendation 214 displayed by the maintenance recommendation application 210 in the vehicle HMI 212. In an example, the maintenance recommendation 214 may be displayed (e.g., upon vehicle 31 startup, responsive to generation, etc.) when the maintenance recommendation application 210 determines that a maintenance recommendation 214 has been generated by the maintenance recommendation application 210 for which the recommended maintenance has not yet been performed. As displayed, the maintenance recommendation 214 includes a message 402 indicating a proposed day for performing vehicle 31 maintenance required by the maintenance schedule 202 as well as a maintenance procedure unrelated to the maintenance schedule 202 (e.g., a car wash). The user interface 400 further includes additional controls configured to receive user input regarding acceptance or rejection of the provided maintenance recommendation 214. For instance, the user interface may include a yes control 404 configured to receive input from the user (e.g., touch input, voice input, etc.) indicative of acceptable of the maintenance recommendation 214, and a no control 406 configured to receive input from the user indicative of rejection of the maintenance recommendation 214.

If the user accepts the maintenance recommendation 214, the maintenance recommendation application 210 may be configured to utilize the maintenance scheduler service 208 to finalize an appointment for the user to have the maintenance performed to the vehicle 31. If the user rejects the maintenance recommendation 214, in some cases the main-

tenance recommendation 214 may be offered again at a later time (e.g., upon next key-on, the next day, etc.). In other cases, if the maintenance recommendation 214 is for a high priority maintenance item where the vehicle 31 must not be driven until the maintenance is performed, the maintenance recommendation application 210 may prevent dismissal of the maintenance recommendation 214 until the maintenance condition is addressed.

FIG. 5 illustrates an exemplary process 500 for providing maintenance recommendations 214. The process 500 may be performed, for example, by the maintenance recommendation application 210 executed by the VCS 1 or the nomadic device 53.

At operation 502, the maintenance recommendation application 210 determines a maintenance indication 306. For example, the maintenance estimator module 304 of the maintenance recommendation application 210 may identify whether elements of the vehicle data 302 retrieved from the vehicle sensors 204 are indicative of maintenance that may be required according to the maintenance schedule 202 of the vehicle 31. When the maintenance estimator module 304 identifies that maintenance that may be required according to the maintenance schedule 202, the maintenance estimator module 304 may generate a maintenance indication 306. The maintenance indication 306 may indicate the item of maintenance that should be performed as well as a severity level for the item of maintenance that should be performed.

At operation 504, the maintenance recommendation application 210 determines a maintenance time indication 312. For example, the maintenance recommendation application 210 may identify weather conditions suitable for a maintenance procedure unrelated to the maintenance schedule 202 but preferred by the driver according to the driver maintenance preferences 314. The maintenance recommendation application 210 may further utilize the weather forecast module 308 of the maintenance recommendation application 210 to query the weather service 206 for current or forecast weather conditions related to the timing for which the maintenance indication 306 indicates that maintenance should be performed. Based on the weather forecast data 310, the weather forecast module 308 may generate a maintenance time indication 312 indicative of one or more times deemed suitable for performing the a maintenance procedure unrelated to the maintenance schedule 202 (e.g., appropriate weather for a car wash).

At operation 506, the maintenance recommendation application 210 generates a maintenance recommendation 214. For example, the maintenance management module 316 of the maintenance recommendation application 210 may receive maintenance indications 306 from the maintenance estimator module 304, receive maintenance time indications 312 from the weather forecast module 308, and determine, based on the driver maintenance preferences 314, a maintenance recommendation 214 to be provided to the driver via the vehicle HMI 212. The maintenance management module 316 may accordingly determine, based on the maintenance time indications 312, a time suitable for maintenance procedure unrelated to the vehicle maintenance schedule 202, and may generate a maintenance recommendation 214 suggesting that both the maintenance procedure unrelated to the maintenance schedule 202 and the maintenance indicated by the maintenance indications 306 be performed at the time suitable for the maintenance procedure unrelated to the vehicle maintenance schedule 202. For instance, the driver maintenance preferences 314 may indicate that the user does not wish to be reminded to wash the vehicle 31 for a specified amount of days before a forecast

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storm or after a recorded storm, so the maintenance recommendation application 210 may accordingly generate the maintenance recommendation 214 in compliance with the driver maintenance preferences 314 responsive to the information received from the weather forecast module 308.

At operation 508, the maintenance recommendation application 210 displays the maintenance recommendation 214 via the vehicle HMI 212. In an example, FIG. 4 illustrates an exemplary user interface 400 including display of a maintenance recommendation 214. From the user interface 400, the user may select to schedule the recommended maintenance. After operation 508, the process 500 ends.

FIG. 6 illustrates an exemplary process 600 for updating the VCS 1 with respect to maintenance being performed to the vehicle 31. As with the process 500, the process 600 may be performed, for example, by the maintenance recommendation application 210 executed by the VCS 1 or the nomadic device 53.

At operation 602, the maintenance recommendation application 210 receives an indication of completed vehicle 31 maintenance. In an example, the maintenance recommendation application 210 may identify based on received vehicle data 302 (e.g., fluid level/quality, tire pressure, etc.) that the recommended vehicle 31 maintenance has been completed. In another example, the maintenance recommendation application 210 may identify that the vehicle 31 has spent at least a predetermined amount of time at a location (car wash, dealership, etc.) at which vehicle 31 maintenance was likely performed, and responsive to the identification may provide a user interface prompt to receive confirmation that the recommended maintenance has been performed. In yet a further example, the VCS 1 may be configured to receive manual input from the user (e.g., resetting of a maintenance recommendation 214 displayed in the vehicle HMI 212, utilizing a maintenance reset function of the VCS 1, etc.) indicating that the recommended vehicle 31 maintenance was performed. As yet another example, the maintenance recommendation application 210 may determine that the recommended vehicle 31 maintenance has been completed based on maintenance scheduling information for the vehicle 31 retrieved from the maintenance scheduler service 208.

At operation 604, the maintenance recommendation application 210 updates the maintenance recommendation 214. For example, based on receiving the vehicle data 302 or input from the user, the maintenance recommendation application 210 may mark the maintenance recommendation 214 as complete or remove the maintenance recommendation 214 from VCS 1 memory. Accordingly the vehicle HMI 212 may dismiss the maintenance recommendation 214 or otherwise no longer show the maintenance recommendation 214 in the vehicle HMI 212.

At operation 606, the maintenance recommendation application 210 updates the driver maintenance preferences 314. For example, the maintenance recommendation application 210 may update the driver maintenance preferences 314 with respect to the location used to service the vehicle 31, times of day and days of the week during which the vehicle 31 was put into service, and whether maintenance procedures unrelated to vehicle wear items (e.g., car washes, vehicle detailing) were also performed. The driver maintenance preferences 314 may accordingly be used to better inform the maintenance recommendation application 210 in forming future maintenance recommendations 214 for the vehicle 31. After operation 606, the process 600 ends.

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While exemplary embodiments are described above, it is not intended that these embodiments describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention. Additionally, the features of various implementing embodiments may be combined to form further embodiments of the invention.

What is claimed is:

1. A system comprising:
vehicle sensors; and

a processor configured to

receive vehicle data from the vehicle sensors,

determine, based on the vehicle data and a vehicle maintenance schedule, a maintenance indication indicative of vehicle maintenance that is due,

identify a maintenance time indication for performing a weather-specific maintenance procedure unrelated to the vehicle maintenance schedule based on time-frames before and after weather predicted by weather forecast data during which maintenance recommendations are not to be indicated, and

display a maintenance recommendation offering to perform the vehicle maintenance and the weather-specific maintenance procedure at a time indicated by the maintenance time indication.

2. The system of claim 1, wherein the processor is further configured to provide the maintenance recommendation in a vehicle human-machine interface.

3. The system of claim 2, wherein the processor is further configured to:

receive user input accepting the maintenance recommendation, and

schedule the vehicle maintenance and the weather-specific maintenance procedure with a maintenance scheduling service.

4. The system of claim 2, wherein the maintenance recommendation displays a message indicating a proposed day for performing the vehicle maintenance required by the maintenance schedule and the weather-specific maintenance procedure.

5. The system of claim 2, wherein the maintenance recommendation includes user interface controls configured to receive user input regarding acceptance or rejection of the maintenance recommendation.

6. The system of claim 1, wherein the processor is further configured to receive the vehicle data from vehicle sensors connected to a controller area network of the vehicle.

7. The system of claim 1, wherein the processor is further configured to identify the maintenance time indication according to properties of weather appropriate for the weather-specific maintenance procedure and where the weather forecast data is queried by the processor from a weather service.

8. The system of claim 1, wherein the processor is further configured to identify the weather-specific maintenance procedure based on driver maintenance preferences maintained by the vehicle.

9. The system of claim 1, wherein the weather-specific maintenance procedure includes a vehicle wash.

10. The system of claim 1, wherein the maintenance schedule includes at least one of maintenance procedures specified according to a predetermined interval of time, or maintenance procedures specified according to an interval number of miles.

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11. A system comprising:
 vehicle sensors; and
 a processor configured to
 identify, based on driver maintenance preferences, a
 weather-specific maintenance procedure unrelated to
 a vehicle maintenance schedule,
 identify a maintenance time indication according to
 properties of weather appropriate for the weather-
 specific maintenance procedure and weather forecast
 data queried from a weather service using driver
 maintenance preferences indicating timeframes
 before and after predicted weather during which
 maintenance recommendations are not to be indi-
 cated, and
 display a maintenance recommendation offering to
 perform required vehicle maintenance determined
 based on data from the vehicle sensors and the
 weather-specific maintenance procedure at a time
 indicated by the maintenance time indication.

12. The system of claim 11, wherein the processor is
 further configured to determine, based on vehicle data
 received from the vehicle sensors and the vehicle main-
 tenance schedule, a maintenance indication indicative of the
 required vehicle maintenance being due.

13. The system of claim 12, wherein the processor is
 further configured to receive the vehicle data from vehicle
 sensors connected to a controller area network of the
 vehicle.

14. The system of claim 11, wherein the processor is
 further configured to provide the maintenance recommen-
 dation in a vehicle human-machine interface.

15. The system of claim 14, wherein the processor is
 further configured to:
 receive user input accepting the maintenance recommen-
 dation, and
 schedule the required vehicle maintenance and the
 weather-specific maintenance procedure with a main-
 tenance scheduling service.

16. The system of claim 14, wherein the maintenance
 recommendation displays a message indicating a proposed
 day for performing the vehicle maintenance required by the
 maintenance schedule and the weather-specific maintenance
 procedure.

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17. The system of claim 14, wherein the maintenance
 recommendation includes user interface controls configured
 to receive user input regarding acceptance or rejection of the
 maintenance recommendation.

18. The system of claim 11, wherein the weather-specific
 maintenance procedure includes a vehicle wash.

19. The system of claim 11, wherein the maintenance
 schedule includes at least one of maintenance procedures
 specified according to a predetermined interval of time, or
 maintenance procedures specified according to an interval
 number of miles.

20. A method comprising:
 generating, by a processor of a vehicle, using a vehicle
 maintenance schedule and vehicle data received by the
 processor from vehicle sensors over a controller area
 network of the vehicle, a maintenance indication indi-
 cating a maintenance procedure to be performed to the
 vehicle;
 generating, by the processor, a maintenance time indica-
 tion indicative of one or more times deemed suitable
 for performing a maintenance procedure unrelated to
 the maintenance schedule by querying a weather ser-
 vice for weather conditions while accounting for driver
 maintenance preferences indicating timeframes before
 and after the weather during which maintenance rec-
 ommendations are not to be indicated;
 displaying, to a user interface screen of the vehicle, a
 maintenance recommendation suggesting a day suit-
 able for the maintenance procedure unrelated to the
 vehicle maintenance schedule, and suggesting that both
 the maintenance procedure unrelated to the mainte-
 nance schedule and the maintenance indicated by the
 maintenance indication be performed that day; and
 responsive to user input to the screen accepting the
 maintenance recommendation, schedule an appoint-
 ment for the vehicle to have both the maintenance
 procedure unrelated to the maintenance schedule and
 the maintenance indicated by the maintenance indica-
 tion performed.

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